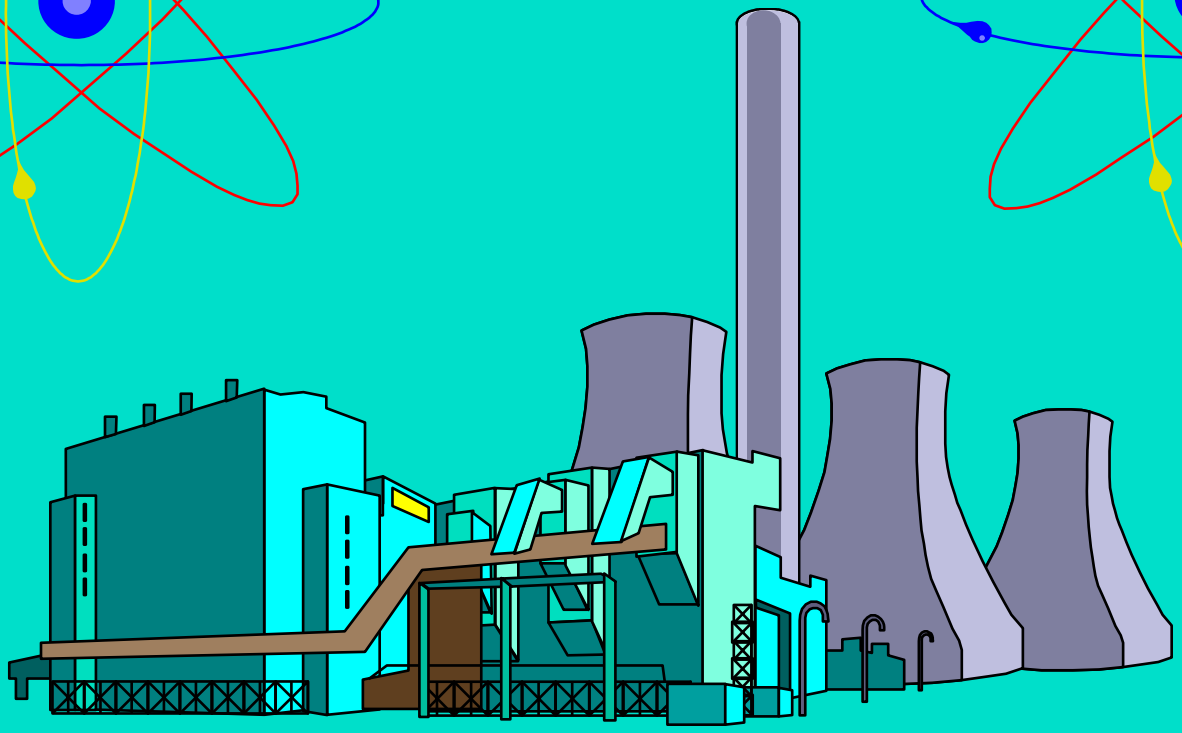
Fundamentals of Radiation



Radiation

- **We cannot eliminate radiation from our environment.**
- **We can however, reduce our risk by controlling our exposure to it.**
- **It comes from the outer space, the ground, and even from within our own bodies.**
- **We use radioactive materials for beneficial purposes.**

Radiation (cont)

- Radiation has always been present in our environment, it was not discovered until the late 1800's.

- Radioactive atoms emit radiation because they are unstable.

Radiation (cont)

- Terms used to express amount of radiation present are:
  - Roentgen
  - Rad
  - cgy
  - Rem

Elements

- Are simple fundamental substances.
- There are at least 106 known elements.
- The first 92 are naturally occurring.
- The remaining elements are man-made & radioactive.

Elements

- 98% of the planet consist of six (6) elements:
  - Iron
  - Silicon
  - Oxygen
  - Sulfur
  - Magnesium
  - Nickel

Questions

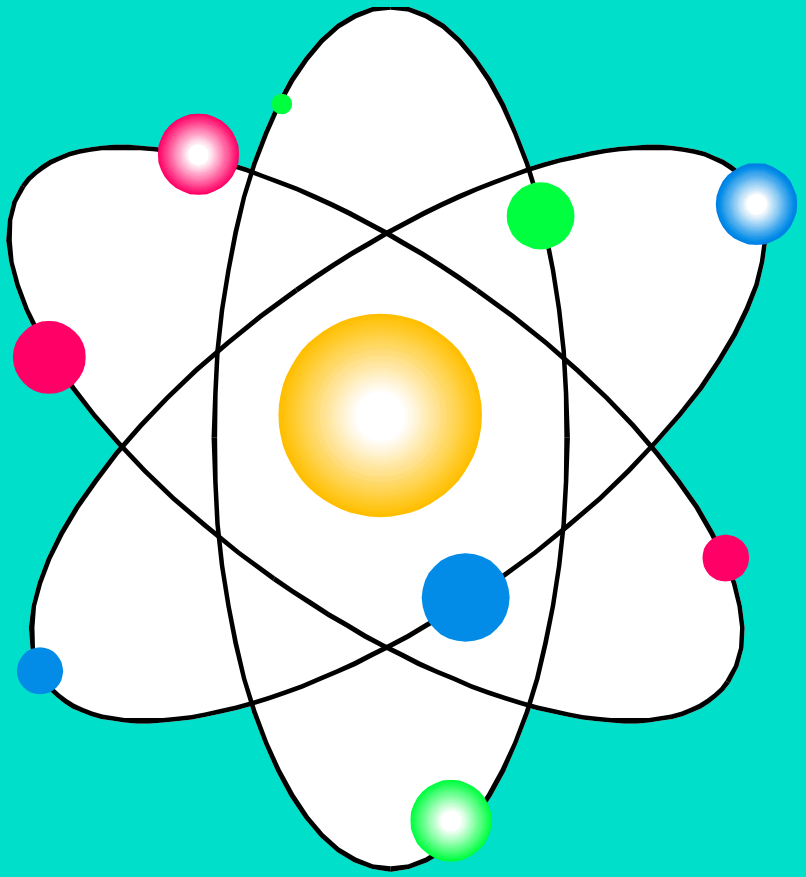
- Where does radiation come from?
- Outer space, ground, our bodies.
- What are the terms used to express the amount of radiation present?
- Roentgen, Rad,CgGy, Rem.

Atom

- Is the smallest unit of an element.

- Composed of:
  - protons
  - neutrons
  - electrons.

Structure of an Atom



Structure of an Atom

- Protons & neutrons are heavy particles that are found in the center or nucleus of the Atom
- The difference between them is their associated electrical charge:
  - Protons: positive charge
  - neutrons: no charge
  - Electrons: are even smaller, negatively charged and orbit the nucleus

3 Main Types of Radiation emitted from Radioactive Atoms

- Alpha Particles
- Beta Particles
- Gamma Rays

Alpha

- They are the heaviest and most highly charged of the nuclear radiation.
- They are less penetrating than beta particles and gamma rays.
- They cannot travel more than 4 to 7 inches in air.

Alpha (cont)

- Can be completely stopped by an ordinary sheet of paper or the outermost layer of the skin.
- Can be harmful if they are ingested or inhaled.

Beta

- Beta particles are smaller and travel much faster than Alpha particles.
- Physically similar to electrons.
- They are not in orbit around an atom.
- They penetrate further into material or tissue.

Beta (cont)

- They can travel several millimeters through tissue, but they generally do not penetrate far enough to reach vital organs.

- Exposure to large amounts of Beta radiation can result in skin burns.

Beta (cont)

- Is considered to be an internal hazard if taken into the body.
  - By eating food, drinking water, or breathing air containing radioactive material.

- Beta emitting contamination can enter the body through unprotected open wounds.

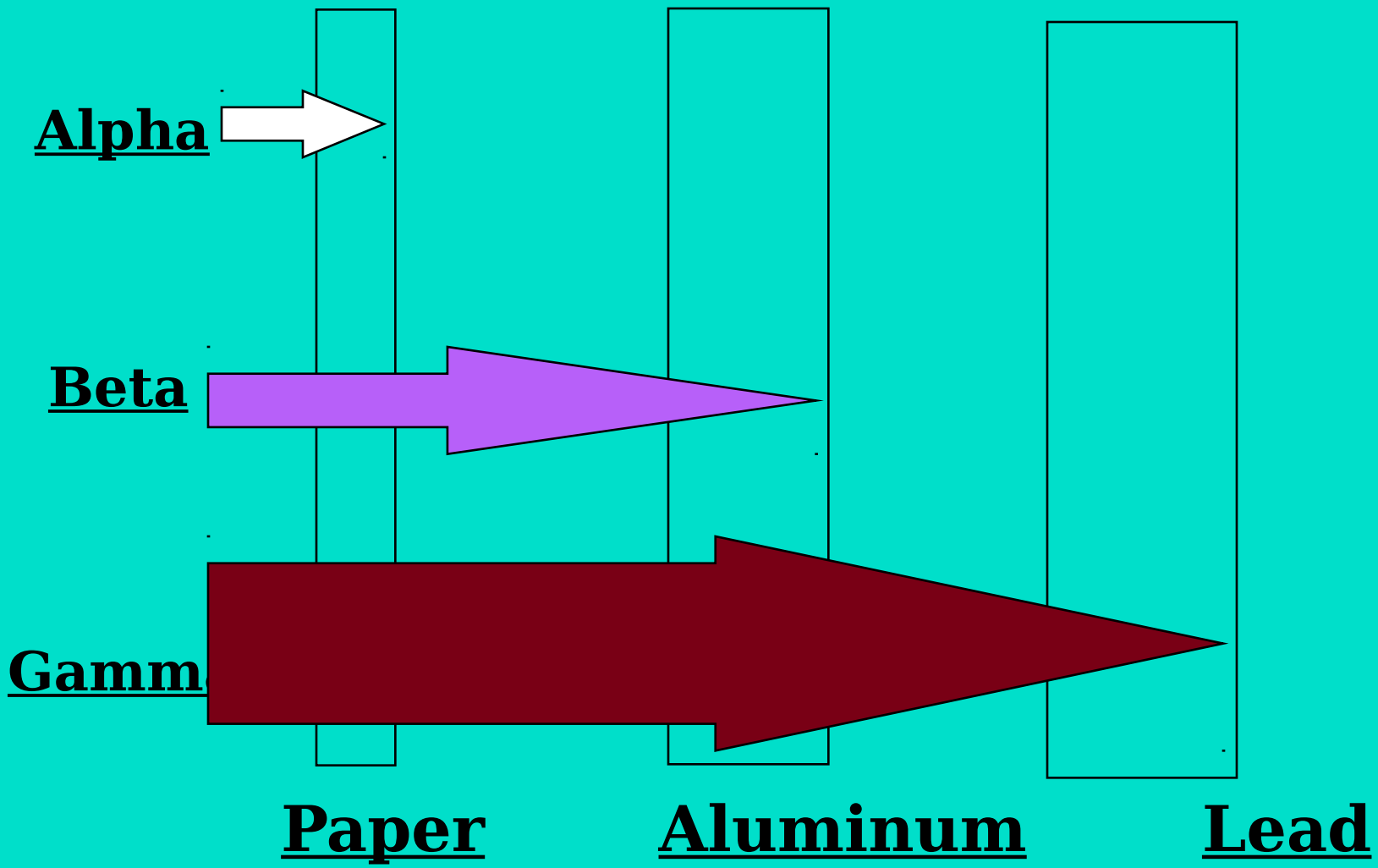
Gamma

- Gamma rays are similar to medical x-rays.
- Gamma rays are a type of Electromagnetic Radiation of high energy (high penetration).
- Gamma rays can travel up to 1 mile (1.6 km) in open air.

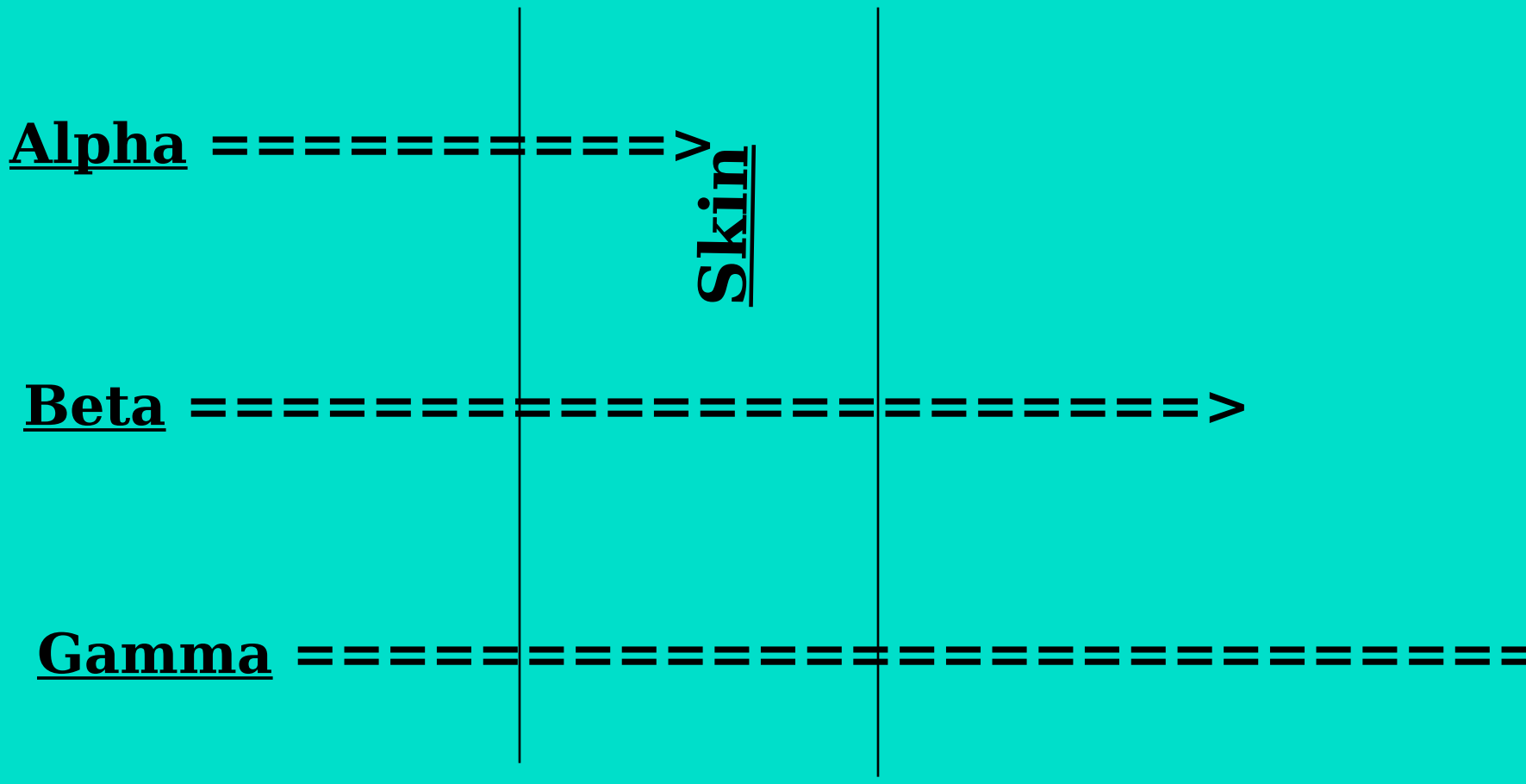
Gamma (cont)

- 2½ inches of dense concrete will absorb 50%.
- Penetrates more deeply into the body.
- Affects the bones in your body.
- Can depress the production of red blood cells

Penetrating Power



Radiation Penetration into skin



QUESTIONS

- What is an Atom composed of?
- Protons, Neutrons, and Electrons
- How far can Alpha particles travel in air?
- 4 to 7 inches
- Beta particles are larger than Alpha
- particles?
- False

Questions (cont)

- How far can Gamma rays travel in open air?
- Up to 1 mile (1.6 km)
- What type of material will absorb 50% of Gamma rays?
- 2 1/2 inches of dense concrete

Neutron Radiation

- Consist of neutrons in motion, however they are not contained in the nucleus of an atom.

- They can travel through space by themselves and in open air

Neutron Radiation

- They can travel up to 3,000 ft.
- They loose their energy mostly by colliding with protons in the nucleus of an atom.

Neutron Radiation (cont)

- When it has lost enough energy, it can be captured by the nucleus making the target atom radioactive.

- The radioactive atoms then emit Alpha, Beta, or Gamma radiation in their attempt to become more stable.

Radiation Measurement Terms

- Since radiation affects people, we must be able to measure its presence.

- Two terms used to relate the amount of radiation received by the body are:
  - exposure
  - dose

Radiation Measurement Terms (cont)

- Dose Rate:
  - The amount of radiation given off or absorbed within a given period of time.
- Dose:
  - An accumulative amount of radiation given off or absorbed.

Radiation Measurement Terms (cont)

- Roentgen:
  - Is the unit used to express the amount of gamma radiation exposure an individual receives.
    - written / abbreviated: “R”.
- Example:
  - an exposure of 50 roentgens would be written
    - 50R

Radiation Measurement Terms (cont)

- It is independent in time over which the exposure occurs:
  - Examples:
    - exposure to 5 R of gamma rays today and 6 R next week = 11 R (is the cumulative gamma radiation exposure)

Radiation Measurement Terms (cont)

- Rad (radiation absorbed dose):
  - It is the basic unit of the absorbed dose of radiation.
- The rad was developed to relate the different types of radiation to the energy they impart in materials.
- The dose of 1 rad indicates the absorption of 100 ergs.

Radiation Measurement Terms (cont)

- erg:
  - is a small but measurable amount of energy

- 1 R of gamma radiation = 1 rad of absorbed dose

Radiation Measurement Terms (cont)

- Cgy (Centigray): NATO STANDARD
  - Is the absorbed radiation dose of the International system of units.
- 1 Cgy = 1 rad
- 100 cgy = 1 gray
- It is the measurement term used with the AN / VDR - 2.

Radiation Measurement Terms (cont)

- Rem (roentgen equivalent man): The rem is unit that relates the dose of any radiation to the biological effect of that dose.
- To indicate the dose an individual receives in the unit rem, the word :rem" _immediately after the magnitude, Example "50 rem"

Radiation Measurement Terms (cont)

- For Gamma rays and Beta particles, 1 rad of exposure results in 1 rem of dose.
- For Alpha particles, 1 rad of dose results in approximately 20 rem of dose.
- For neutrons, 1 rad of exposure results in approximately 10 rem of dose.

Radiation Measurement Terms (cont)

- Exposure rate:
  - is the rate at which an individual is exposed to radiation.

- This is often measured on a per-hour basis
  - Example: 60 R/hr

Questions

- What are the two terms used to expressed the amount or radiation received by the body?
- Exposure and dose
- What are the four radiation measurement terms used?
- rad, R, rem, and Cgy
- What does the term “rad” mean?
- radiation absorbed dose

Natural Background Radiation Sources

- The main sources of natural background radiation are:
  - Cosmic Radiation
  - Terrestrial Sources
  - Radioactivity in the body
- Individuals are exposed to minute amounts of radiation from the environment daily.

Cosmic Radiation

- It reaches the earth primarily from the sun.
- The atmosphere acts as a shield and considerably reduces the amount of cosmic radiation reaching the earth’s surface.

Terrestrial Sources

- Our environment is filled with radioactive materials.
- However, the concentration depends on the type of rock formation.

Radioactivity in the body

- The human body contains very small quantities of radioactive carbon and potassium.
- The radioactive carbons originates in the atmosphere.
- Radioactive potassium is naturally occurring.

Man-Made Radiation Sources

- There are many sources of man-made radiation which may contribute daily to radiation exposure to humans.
- These sources include:
  - Diagnostic Radiology
  - Therapeutic Radiology
  - Occupational Exposure
  - Fallout from Weapons Testing

Diagnostic Radiology

- It is the use of radiation to determine a patients conditions.
- It has been estimated that 75 - 90 % of the total exposure of the population is from this type.

Therapeutic Radiology

- It is the use of radiation to treat a patient:
  - cancer patients.

- Only a small number of people are involved and exposed.

Occupational Exposure

- Occupational exposure is exposure to individuals such as:
  - Nuclear Energy Workers.
  - Industrial Users of Radioactive Materials.
  - Medical Personnel.

Questions

- What are the three main sources of natural background radiation?
- Cosmic radiation, Terrestrial Sources, and Radioactivity in the Body.
- What are the 4 types of man-made radiation sources?
- Diagnostic Radiology, Therapeutic Radiology, Occupational Exposure, and Fallout from Nuclear Weapons.

Biological Effects of Radiation

- An exposure received within a short period of time is called:
  - acute exposure.

- A large acute exposure can result in observable effects, such as:
  - radiation sickness or death, shortly after exposure.

Bio Effects of Radiation (cont)

- The severity depends on the amount of radiation dose.

- Large acute exposure can also result in effects such as cancer that show up after a number of years.

Bio Effects of Radiation (cont)

- A continuous or repetitive exposure is called:
  - chronic exposure.

- Small chronic exposures, such as exposure to background radiation, have no immediately observable effects.

Bio Effects of Radiation
Acute Effects

- Acute radiation sickness symptoms include:
  - Changes in blood cells
  - Skin irritation
  - Vascular changes (blood vessels)
  - Burns
  - Gastrointestinal system effects
  - Radiation Sickness (diarrhea, nausea, vomiting, high fever)
  - Hair loss (epilation)
  - Death

Bio Effects of Radiation Severity Levels

- If the absorbed dose is not known, the following are common symptoms of early radiation sickness:
  - diarrhea
  - nausea
  - vomiting
  - high fever
  - anorexia

Bio Effects of Radiation Severity Levels (cont)

- Later symptoms include:
  - fatigue
  - weight loss
  - abdominal pain
  - drowsiness
  - fever
  - blisters
  - restlessness
  - insomnia

Questions

- The exposure received within a short period of time is called?
- Acute Exposure
- A continuous or repetitive exposure is called?
- Chronic Exposure

Exposure Control Techniques

- Three important factors in protecting individuals from radiation are:
  - Time
  - Distance
  - Shielding
- These factors can greatly reduce the effects of radiation sickness

Exp Control Tech (cont)

- Time:

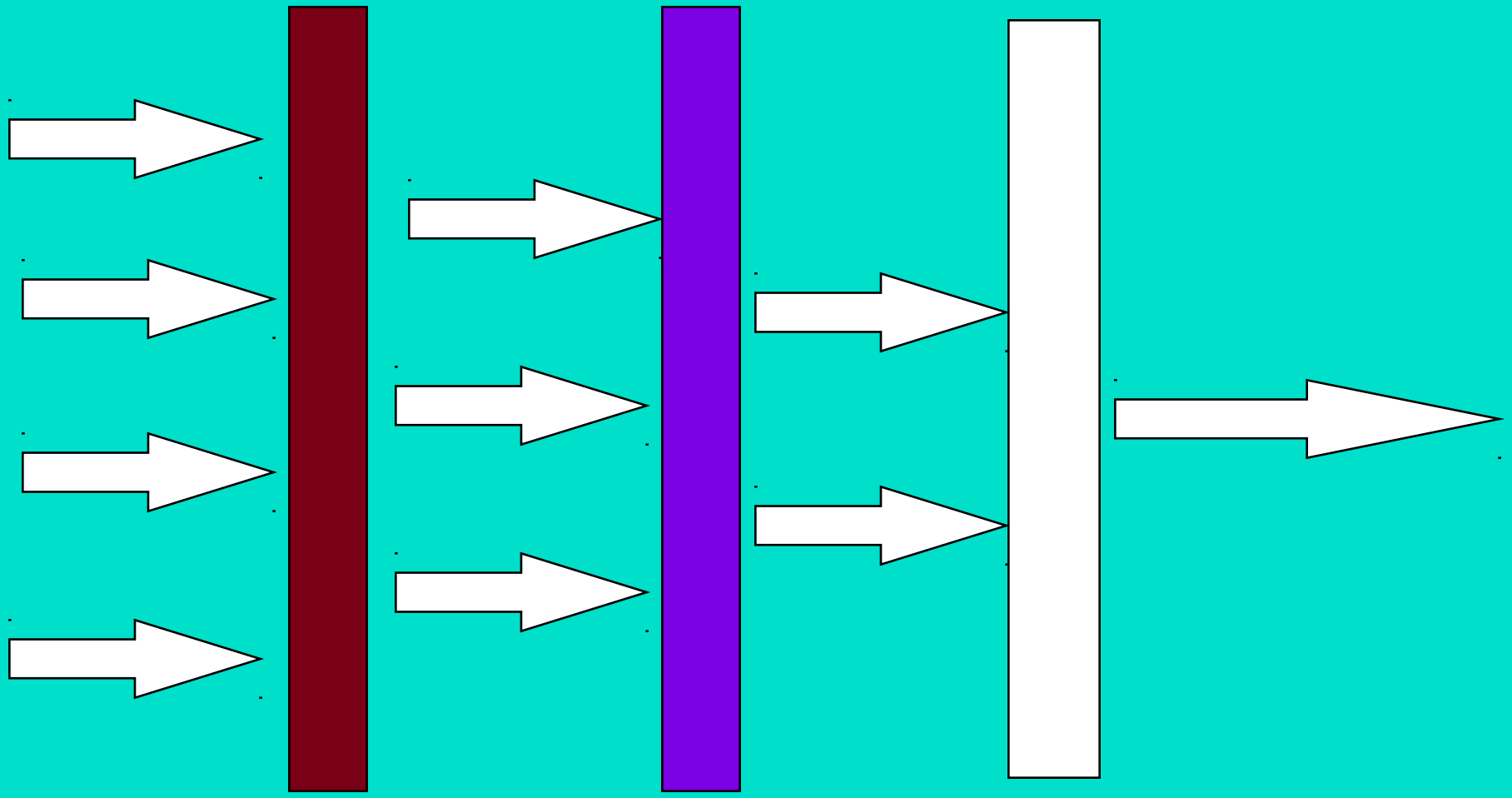
- Distance:

Exp Control Tech (cont)

- Shielding:
  - Adsorption
  - Scattering.

Exp Control Tech (cont)

- Gamma radiation:
  - dense material such as lead is most effective as a shield.
- Beta radiation:
  - can be shielded by relatively thin amounts of wood or plastic.
- Alpha radiation:
  - is shielded by virtually any material.



Effects of Shielding Layers On Exposure Rate

Terminology

- Acute Exposure:
  - exposure received within a short period of time.
- Chronic Exposure:
  - a continuos or repetitive exposure.
- Dose:
  - a general term denoting the quantity of radiation or energy absorbed.

Terminology (cont)

- Dose Rate:
  - the radiation dose delivered during per unit time.
- Cgy:
  - Cgy (NATO STANDARD)
- rad:
  - radiation absorbed dose

Terminology (cont)

- R:
  - roentgen

- Rem:
  - roentgen equivalent man

Questions

- What are the three important factors in protection from radiation?
- Time, Shielding, Distance
- What can be used to shield against alpha radiation?
- Virtually any material

Summary

- Material covered:
  - Structure of an Atom.
  - 3 Main Types of Nuclear Radiation Emitted from Atom.
  - 4 Radiation Measurement Terms.

Summary

- Radiation Measurement Terms
  - 4 Main Sources of Natural Background Radiation.
  - 4 Types of Man-Made Radiation
  - Biological Effects of Radiation Exposure
  - Exposure Control Techniques
  - Terminology